

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A motor control system for controlling a brushless and sensorless DC motor system having a plurality of phase coils, comprising:

a motor control integrated circuit having a plurality of motor driver outputs and a control input for operating said plurality of ~~output drivers~~ motor driver outputs, said plurality of motor driver outputs coupled to the plurality of phase coils; and

a fault detection circuit coupled with said control input and capable of selectively switching the state of said control input to momentarily and substantially simultaneously disable all of said plurality of ~~output drivers~~ motor driver outputs, said fault detection circuit being coupled to at least one of the plurality of phase coils and capable of detecting a threshold back EMF voltage from the at least one of the plurality of phase coils while all of said ~~output drivers~~ motor driver outputs are momentarily disabled and providing a fault signal if the sensed back EMF is below a preset threshold.

Claim 2 (original): The motor control system of claim 1, wherein said fault detection circuit includes a capacitor coupled to the at least one of the plurality of phase coils, said capacitor receiving back EMF and said fault detection circuit detecting said threshold back EMF voltage across said capacitor.

Claim 3 (original): The motor control system of claim 2, wherein said fault detection circuit includes at least one optical isolator coupling the at least one of the plurality of phase coils and said capacitor.

Claim 4 (currently amended): A motor control system for controlling a brushless and sensorless DC motor system having a plurality of phase coils, comprising:

a motor control integrated circuit having a plurality of motor driver outputs and a control input for operating said plurality of ~~output drivers~~ motor driver outputs, said plurality of motor driver outputs coupled to the plurality of phase coils; and

a fault detection circuit coupled with said control input and capable of selectively switching the state of said control input to momentarily disable said plurality of ~~output drivers~~ motor driver outputs, said fault detection circuit being coupled to at least one of the plurality of phase coils and capable of detecting a threshold back EMF voltage from the at least one of the plurality of phase coils, wherein said fault detection circuit includes a microcontroller having an analog-to-digital converter coupled to the at least one of the plurality of phase coils and an output port coupled to said control input.

Claim 5 (original): The motor control system of claim 4, further comprising at least one optically coupled isolator coupling said analog-to-digital converter and the at least one of the plurality of phase coils.

Claim 6 (previously presented): The motor control system of claim 4, further comprising software enabling said microcontroller to:

switch a control signal coupled to said control input, momentarily disabling said plurality of motor driver outputs;

measure back EMF generated by the at least one of the plurality of phase coils and received by said analog-to-digital converter; and

switch said control signal coupled to said control input upon measuring back EMF above a threshold level, enabling said plurality of motor driver outputs.

Claim 7 (original): The motor control system of claim 6, wherein said software further enables said microcontroller to delay switching said control signal for a preset time upon measuring back EMF below a threshold level in order to delay re-enabling said plurality of motor driver outputs.

Claim 8 (original): The motor control system of claim 7, wherein said microcontroller is capable of providing a fault signal and said software further enables said microcontroller to switch said control signal to disable said plurality of motor driver outputs, and to provide said fault signal upon measuring a back EMF below a threshold level more than a preset number of times.

Claim 9 (currently amended): A motor control system for controlling a brushless and sensorless DC motor system in a hermetic compressor, said system having a plurality of phase coils, comprising:

a motor control integrated circuit having a plurality of motor driver outputs and a control input for operating said plurality of ~~output drivers~~ motor driver outputs, said plurality of motor driver outputs coupled to the plurality of phase coils; and

a fault detection circuit coupled with said control input, said fault detection circuit capable of selectively switching the state of said control input to momentarily and substantially simultaneously disable all of said plurality of ~~output drivers~~ motor driver outputs, said fault detection circuit capable of detecting a plurality of electrical and nonelectrical fault conditions of the motor system, said fault detection circuit capable of providing a control signal to said control input to disable all of said plurality of ~~output drivers~~ motor driver outputs upon detection of at least one of said plurality of electrical and nonelectrical fault conditions relating to said compressor.

Claim 10 (currently amended): A motor control system for controlling a brushless and sensorless DC motor system having a plurality of phase coils, comprising:

a motor control integrated circuit having a plurality of motor driver outputs and a control input for operating said plurality of ~~output drivers~~ motor driver outputs, said plurality of motor driver outputs coupled to the plurality of phase coils;

a fault detection circuit coupled with said control input and capable of detecting a plurality of electrical and nonelectrical fault conditions of the motor system, said fault detection circuit capable of providing a control signal to said control input to disable said plurality of ~~output drivers~~ motor driver outputs upon detection of at least one of said plurality of electrical and nonelectrical fault conditions; and

a temperature sensing circuit coupled to said fault detection circuit.

Claim 11 (original): The motor control system of claim 10, further comprising a motor housing and a temperature sensor thermally coupled to said motor housing and electrically coupled to said temperature sensing circuit.

Claim 12 (original): The motor control system of claim 10, further comprising a temperature sensor and a compressor driven by said motor and having a housing, said temperature sensor thermally coupled to said housing and electrically coupled to said temperature sensing circuit.

Claim 13 (original): The motor control system of claim 10, further comprising:

a transistor power bridge circuit coupled between said plurality of motor driver outputs and the plurality of phase coils;

a heat sink thermally coupled to said transistor power bridge circuit; and

a power bridge temperature sensor thermally coupled to said heat sink and electrically coupled to said temperature sensing circuit.

Claim 14 (original): The motor control system of claim 9, further comprising a voltage sensing circuit coupled to a voltage supply of the system, said voltage sensing circuit coupled to said fault detection circuit, said fault detection circuit capable of switching said control input to disable said plurality of motor driver outputs upon said voltage supply being above or below a preset limit.

Claim 15 (currently amended): The motor control system of claim 9, further comprising a current sensing circuit coupled to at least one of the plurality of phase coils, said current sensing circuit coupled to said fault detection circuit, said fault detection circuit capable of switching said control input to disable said plurality of motor driver outputs ~~drivers~~ upon a detected phase coil current being above or below a preset limit.

Claim 16 (currently amended): The motor control system of claim 9, wherein said motor control integrated circuit outputs a speed signal related to motor speed, and said fault detection circuit is capable of receiving said speed signal and switching said control input to disable said plurality of motor driver outputs ~~drivers~~ upon said motor speed being above or below a preset motor speed limit.

Claim 17 (original): The motor control system of claim 9, wherein said control input is an over current protection input of said motor control integrated circuit.

Claim 18 (currently amended): A method for detecting faults in a motor control system for a brushless and sensorless DC motor system having a plurality of phase coils, comprising the steps of:

providing a motor control integrated circuit having a plurality of power driver outputs ~~drivers~~ coupled to the plurality of phase coils, and having a control input capable of selectively enabling the plurality of power driver outputs ~~drivers~~;

momentarily and substantially simultaneously disabling all of said plurality of power driver outputs ~~drivers~~;

detecting a motor system fault by measuring EMF on at least one of the plurality of phase coils while all of said plurality of power driver outputs ~~drivers~~ are momentarily disabled; and

switching the control input to disable all of the plurality of power driver outputs ~~drivers~~ upon detecting a motor system fault indicated by measured EMF below a preset threshold to thereby stop motor operation.

Claim 19 (currently amended): The method of claim 18, wherein the step of detecting a motor system fault includes the further steps of:

switching the control input to momentarily disable the plurality of power driver outputs ~~drivers~~;

then measuring the back EMF generated in the plurality of phase coils; and

then switching the control input to enable the plurality of ~~output drivers~~ power driver outputs.

Claim 20 (currently amended): A method for detecting faults in a motor control system for a brushless and sensorless DC motor system having a plurality of phase coils, comprising the steps of:

providing a motor control integrated circuit having a plurality of power driver outputs ~~drivers~~ coupled to the plurality of phase coils, and having a control input capable of selectively enabling the plurality of power driver outputs ~~drivers~~;

detecting a motor system fault by measuring EMF on at least one of the plurality of phase coils; and

switching the control input to disable the plurality of power driver outputs ~~drivers~~ upon detecting a motor system fault indicated by excess, measured EMF below a preset threshold to thereby stop motor operation;

wherein the step of detecting a motor system fault includes the steps of:

measuring the temperature of a portion of the motor system; and

determining a fault upon the measured temperature exceeding a preset threshold.

Claim 21 (original): The method of claim 18, wherein the step of detecting a motor system fault includes the steps of:

measuring the supply voltage of the motor; and
determining a fault upon the measured supply voltage being above or below a preset voltage threshold.

Claim 22 (original): The method of claim 18, wherein the step of detecting a motor system fault includes the steps of:

measuring the supply current for at least one of the plurality of phase coils; and
determining a fault upon the measured supply current being above or below a preset current threshold.

Claim 23 (currently amended): A method for detecting faults in a motor control system for a brushless and sensorless DC motor system having a plurality of phase coils, comprising the steps of:

providing a motor control integrated circuit having a plurality of power driver outputs ~~drivers~~ coupled to the plurality of phase coils, and having a control input capable of selectively enabling the plurality of power driver outputs ~~drivers~~;

detecting a motor system fault by measuring EMF on at least one of the plurality of phase coils; and

switching the control input to disable the plurality of power driver outputs ~~drivers~~ upon detecting a motor system fault indicated by excess, measured EMF below a preset threshold to thereby stop motor operation;

wherein the motor system includes a compressor driven by the motor, and wherein the step of detecting a motor system fault includes the steps of:

determining a minimum motor speed below which the compressor may be damaged due to lack of adequate lubrication;

measuring the motor speed; and

determining a fault upon the measured motor speed being above or below the minimum motor speed.

Claim 24 (currently amended): A method for detecting faults in a motor control system for a brushless and sensorless DC motor system having a plurality of phase coils, comprising the steps of:

providing a motor control integrated circuit having a plurality of power driver outputs ~~drivers~~ coupled to the plurality of phase coils, and having a control input capable of selectively enabling the plurality of power driver outputs ~~drivers~~;

detecting a motor system fault by measuring EMF on at least one of the plurality of phase coils; and

switching the control input to disable the plurality of power driver outputs ~~drivers~~ upon detecting a motor system fault indicated by excess, measured EMF below a preset threshold to thereby stop motor operation;

wherein the motor system includes a compressor driven by the motor, and wherein the step of determining a motor system fault includes the steps of:

determining a maximum motor speed above which compressor valve damage may occur;

measuring the motor speed; and

determining a fault upon the measured motor speed exceeding the maximum motor speed.

Claim 25 (currently amended): A method for detecting a locked or stopped rotor in a motor control system for a brushless and sensorless DC motor system having a plurality of phase coils driven by power driver outputs ~~drivers~~, comprising the steps of:

momentarily and substantially simultaneously disabling all of the power driver outputs ~~drivers~~;

then measuring the back EMF generated from the plurality of phase coils while all of the power driver outputs ~~drivers~~ are momentarily disabled; and

then enabling all of the power driver outputs ~~drivers~~ after a time period dependent on the measured back EMF.

Claim 26 (original): The method of claim 25, further comprising the following steps after the step of then measuring the back EMF:

if measured back EMF is above a preset threshold, setting the time period to zero.

Claim 27 (currently amended): A method for detecting a locked or stopped rotor in a motor control system for a brushless and sensorless DC motor system having a plurality of phase coils driven by power driver outputs ~~drivers~~, comprising the steps of:

disabling the power driver outputs drivers;
then measuring the back EMF generated from the plurality of phase coils;
then enabling the power driver outputs drivers after a time period dependent on the measured back EMF;
if measured back EMF is above a preset threshold, setting the time period to zero;
incrementing a counter each time measured back EMF is below the preset threshold; and
upon the counter exceeding a preset limit, disabling the power driver outputs drivers.

Claim 28 (currently amended): A method for detecting a locked or stopped rotor in a motor control system for a brushless and sensorless DC motor system having a plurality of phase coils driven by power driver outputs drivers, comprising the steps of:

disabling the power driver outputs drivers;
then measuring the back EMF generated from the plurality of phase coils;
then enabling the power driver outputs drivers after a time period dependent on the measured back EMF;
measuring the temperature of a portion of the motor system; and
upon the measured temperature exceeding a threshold, disabling the power driver outputs drivers.

Claim 29 (currently amended): The method of claim 25, further comprising the steps of:
measuring a motor supply voltage; and
upon the measured voltage being above or below a preset range, disabling the power driver outputs drivers.

Claim 30 (currently amended): The method of claim 25, further comprising the steps of:
measuring a motor supply current supplied to at least one of the plurality of phase coils,
and
upon the measured current being above or below a preset range, disabling the power driver outputs drivers to the plurality of phase coils.

Claim 31 (currently amended): A method for detecting a locked or stopped rotor in a motor control system for a brushless and sensorless DC motor system having a plurality of phase coils driven by power driver outputs drivers, comprising the steps of:

disabling the power driver outputs ~~drivers~~;
then measuring the back EMF generated from the plurality of phase coils; and
then enabling the power driver outputs ~~drivers~~ after a time period dependent on the measured back EMF;

wherein the motor system includes a compressor driven by the motor, and further comprising the steps of:

determining a minimum motor speed below which the compressor may be damaged due to lack of adequate lubrication;
determining the motor speed; and
upon the motor speed being below the minimum motor speed, disabling the power driver outputs ~~drivers~~.

Claim 32 (currently amended): The method of claim 25, wherein the motor system includes a compressor having valves and driven by the motor, and further comprising the steps of:

determining a maximum motor speed above which the valves may be damaged;
measuring the motor speed; and
upon the motor speed exceeding the maximum motor speed, disabling the power driver outputs ~~drivers~~.

Claim 33 (original): A fluid handling system, comprising:

a pump;
a brushless DC motor for driving said pump, said motor having a plurality of phase coils;
and
a motor control system coupled to said motor, said motor controller system including:
a motor control circuit having at least one motor driver output coupled to said plurality of phase coils; and
a microcontroller having an A/D converter coupled to at least one of said plurality of phase coils and having software enabling said microcontroller to provide an output signal coupled to said motor control circuit for momentarily disabling said at least one motor driver output, said microcontroller capable of measuring a voltage level of back EMF generated in said at least one of said plurality of phase coils upon said at least one motor driver output being disabled.

Claim 34 (original): The fluid handling system of claim 33, wherein said pump includes a compressor.

Claim 35 (original): The fluid handling system of claim 33, wherein said software enables said microcontroller to provide said output signal to keep said at least one motor driver output disabled upon said voltage level being below a preset limit.

Claim 36 (currently amended): An actuator control system for controlling a sensorless DC actuator having a plurality of phase coils, comprising:

an actuator control integrated circuit having a control input and a plurality of driver outputs ~~output drivers~~, said control input adapted for selectively disabling said driver outputs ~~output drivers~~, said driver outputs ~~output drivers~~ coupled to the plurality of phase coils; and

a voltage measuring circuit coupled with the plurality of phase coils and providing a control signal coupled with said control input;

said voltage measuring circuit capable of selectively switching the state of said control input to momentarily and substantially simultaneously disable all of said driver outputs ~~output drivers~~;

said voltage measuring circuit measuring a voltage received from the plurality of phase coils upon said voltage measuring circuit momentarily providing said control signal to substantially simultaneously disable all of said driver outputs ~~output drivers~~;

said voltage measuring circuit further providing said control signal upon said received voltage being below a preset threshold.

Claim 37 (original): The actuator control system of claim 36, wherein the actuator includes a brushless DC motor and the actuator control integrated circuit is adapted for brushless DC motor control.

Claim 38 (original): The actuator control system of claim 37, wherein said voltage measuring circuit includes a microcontroller.

Claim 39 (previously presented): The actuator control system of claim 37, wherein said voltage measuring circuit includes a capacitor coupled to the plurality of phase coils and said received voltage is measured across said capacitor.